DEFENSE THREAT REDUCTION AGENCY
SBIR FY04.1 Proposal Submission

The Defense Threat Reduction Agency (DTRA) is actively involved in meeting current threats to the Nation and working toward reduction of threats of all kinds in the future. To meet these requirements, the Agency is seeking small businesses with strong research and development capability. Expertise in weapons effects (blast, shock and radiation), arms control, chemical and biological defense, and counterproliferation technologies will be beneficial. Proposals (technical and cost) will be accepted only by electronic submission at www.dodsbir.net.

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Threat Reduction Agency
ATTN: Mr. Ron Yoho, SBIR Program Manager
8725 John J. Kingman Drive, MSC 6201
Fort Belvoir, VA 22060-6201
E-mail: ron.yoho@dtra.mil

Use of e-mail is encouraged for correspondence purposes.

DTRA has identified 12 technical topics numbered DTRA 04-001 through DTRA 04-012 . Proposals must be submitted electronically. Proposals which do not address the topics will not be considered. The current topics and topic descriptions are included below. The DTRA technical offices that manage the research and development in these areas initiated these topics. Proposals may define and address a subset of the overall topic scope. Questions concerning the topics should be submitted to Mr. Yoho at the above address, to the POC identified for the topic (during the presolicitation period), or through the SITIS system.

Potential offerors must submit proposals in accordance with the DoD Program Solicitation document at www.dodsbir.net/solicitation. Consideration will be limited to those proposals that do not exceed $100,000 and six months of performance. For information purposes, Phase II considerations are limited to proposals that do not exceed $750,000 and 24 months of performance.

DTRA selects proposals for award based on the evaluation criteria contained in this solicitation document consistent with mission priorities and subject to available funding. As funding is limited, DTRA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DTRA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals applicable to more than one DTRA topic must be submitted under each topic.

While funds have not specifically been set aside for bridge funding between Phase I and Phase II, DTRA does not preclude FAST TRACK Phase II awards, and the potential offeror is advised to read carefully the conditions set out in this solicitation.

Notice of award will appear first in the Agency Web site at http://www.dtra.mil. Unsuccessful offerors may receive debriefing upon written request only. E-mail correspondence is considered to be written correspondence for this purpose and is encouraged.

DTRA accepts Phase II proposals only upon a specific invitation which will be based on Phase I progress and/or results as measured against the criteria in Section 4.3 and relevance to DTRA mission priorities. Phase II invitations are typically issued in early to mid-November with proposals being due in early January. DTRA does not utilize a Phase II Enhancement process.

DTRA 04.1 Topic List

DTRA 04.1 Topic Descriptions

DTRA04-001 TITLE: Shielded Special Nuclear Material Detector

TECHNOLOGY AREAS: Materials/Processes, Sensors, Nuclear Technology

OBJECTIVE: The Shielded Special Nuclear Material (SSNM) detection program goal is to explore and develop means to detect and identify shielded radiological materials with emphasis on special nuclear materials such as uranium, plutonium, and neptunium.

DESCRIPTION: The Defense Threat Reduction Agency (DTRA) safeguards America's interests from weapons of mass destruction (chemical, biological, radiological, nuclear and high explosives) by controlling and reducing the threat and providing quality tools and services for the warfighter. DTRA’s Combat Support (CS) Directorate provides emergency response support to the Geographic Combatant Commanders (GCCs) for matters involving weapons of mass destruction (WMD) events.

The recent threat associated with the development of nuclear, chemical, biological armament and the many covert ways of delivering this type of ordnance have made detection even more important. Furthermore, nuclear weapon’s ingredients are usually shielded to avoid detection and physiological damage to the carrier. Current nuclear detection technologies usually attempt to detect gamma and/or neutron radiation and are limited to the boundaries of the inverse square law. Once the radioactive material is fully shielded, detection becomes a nearly impossible task. Current general guidelines for detection are to detect 25g-1kg of radiological material at 5-300m within 15 seconds with emphasis on special nuclear materials such as uranium, plutonium, and neptunium. Hence, there is a requirement to develop and demonstrate an unconventional methodology that can non-invasively detect nuclear material through shielding.

PHASE I: Identify and define the proposed concept and develop key component technological milestones to demonstrate feasibility of concept.

PHASE II: Using results from Phase I, fabricate prototype, define field test objectives, and conduct limited testing.

PHASE III: Using results from Phase II, design and develop operational low rate initial production (LRIP), and demonstrate utility for commercial and military applications.

REFERENCES:

1. "Defense Threat Reduction Agency, 2003 Strategic Plan", http://www.dtra.mil.

2. "Defense Threat Reduction Agency, Weapons of Mass Destruction Terms Reference Handbook", September 2001.

3. DOD Directive 5105.62, "Defense Threat Reduction Agency", September 1998.

4. DOD Directive 5210.63, "Security of Nuclear Reactors and Special Nuclear Materials", April 1990.

5. Dr. Bruce Blair, Center for Defense Information, "Terrorism Project", October 2001, http://www.cdi.org/terrorism/nuclear.cfm.

6. Peurrung AJ. 2002. "On the Long-Range Detection of Radioactivity Using Electromagnetic Radiation." Nuclear Instruments and Methods in Physics Research. Section A, Accelerators, Spectrometers, Detectors and Associated Equipment 481(1-3):731-738.

7. "Ultraviolet Light and Fluorescent Minerals" by Thomas Warren et al (1995)

8. Konstantin N. Borozdin, et al.,"Surveillance: Radiographic imaging with cosmic-ray muons", Nature 422, 277 (20 March 2003).

KEYWORDS: nuclear detection; antiterrorism; weapons of mass destruction;

DTRA04-002 TITLE: Improve high fidelity weather forecast reliability

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: DTRA requires the ability to identify the meteorological mechanisms driving locally forced mesoscale flows in complex heterogeneous physiographical environments that are important to plume dispersion in the boundary layer. Additionally, DTRA requires improved understanding of the meteorological mechanisms sensitivities to physiographical and anthropogenic data inputs, creation of algorithms to operationally ingest the data with existing DTRA numerical weather prediction models, and validation of the operational application of the developed technologies.

DESCRIPTION: The Defense Threat Reduction Agency (DTRA) operates a suite of mesoscale numerical weather prediction (NWP) models in support of the atmospheric transport and dispersion model embedded in the Hazard Prediction and Assessment Capability (HPAC). Accurate atmospheric transport and dispersion predictions for near and surface releases of chemical, biological, and radiological agents is highly dependent on the accuracy of the predicted wind field in the atmospheric boundary layer.

With the availability of economic high powered computing platforms, the high fidelity mesoscale NWP models in use at DTRA are capable of developing the fine scale meteorological features that are observed over complex heterogeneous physiographical regions during periods of weak synoptic forcing. However, these features are not depicted with sufficient accuracy to be of reliable use in HPAC hazard forecasting. While contributing mechanisms are well documented in the literature, an increased understanding of the physiographical and anthropogenic data required, and their application in the modeling systems, is required to reliably forecast the weather inputs to HPAC.

Therefore DTRA requires that the contributing high fidelity meteorological processes, and the data required to simulate them, be identified. DTRA also requires that the resulting technologies be implemented into its operational modeling processes and validated so that HPAC plume prediction can be driven from forecast model data with confidence in complex heterogeneous physiographical environments.

PHASE I: Identify the important meteorological mechanisms driving locally forced mesoscale flows and the contributing physiographical and anthropogenic data requirements. Investigate the sensitivities of the mechanisms to data inputs and their impact on HPAC plume forecasts.

PHASEII: Develop prototype system that will extract these unique data elements from the operational data feeds, operationally ingest data into the modified modeling systems, and validate the impacts on day to day forecast accuracy and plume prediction measures of effectiveness.

PHASE III: The outcomes of the investigation will have a wide variety of military and commercial applications in war theatre and civil weather forecasting, and in theatre and homeland security plume hazard analysis applications.

REFERENCES:
Michalakes, J., R. Loft, A. Bourgeois (2001): "Performance-Portability and the Weather Research and Forecast Model" in on-line proceedings of the HPC Asia 2001 conference, Gold Coast, Queensland, Australia, September 24-28, 2001

Michalakes, J., S. Chen, J. Dudhia, L. Hart, J. Klemp, J. Middlecoff, and W. Skamarock (2001): "Development of a Next Generation Regional Weather Research and Forecast Model" in Developments in Teracomputing: proceedings of the Ninth ECMWF Workshop on the Use of High Performance Computing in Meteorology. Eds. Walter Zwieflhofer and Norbert Kreitz. World Scientific, Singapore. pp. 269-276.

Cassano, J.J., T.R. Parish, and J.C. King, 2000: Evaluation of turbulent surface flux parameterizations for the stable surface layer over Halley, Antarctica. Mon. Wea. Rev., 129, 26--46.

Chen, Chia-Rong -- Lamb, Peter J., 1997: Improved treatment of surface evapotranspiration in a mesoscale numerical model. Part I: Via the installation of the Penman-Monteith method. TAO, Taiwan, 8(4), 481-508.

KEYWORDS: Meteorology, numerical weather prediction, NWP, weather, physiographical, anthropogenic, mesoscale, boundary layer

DTRA04-003 TITLE: New methods to discriminate forecast skill in mesoscale weather predictions and characterization and application of model error statistics

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: DTRA requires the capability to specifically determine both the degree of accuracy and the error matrix statistics of any given high fidelity numerical weather prediction (NWP) model solution so that this information can be used in its hazard prediction and assessment capability (HPAC) in both deterministic and probabilistic analyses.

DESCRIPTION: Current metrics fail to support the scientific consensus that high resolution mesoscale NWP models produce better wind forecasts than models of lower resolution. In a qualitative analysis, high resolution NWP models produce more realistic flows than coarser models, but large scale validation statistics generally do not confirm this quantitatively. The commonly held belief is that the measures of skill that are used to determine the accuracy of large scale NWP models are highly sensitive to small spatial and temporal displacements in the flow solution of a high fidelity NWP model. DTRA seeks innovative approaches to the validation and determination of error characteristics in mesoscale NWP models. The error characteristics should then be applicable along with the NWP solution as inputs to HPAC to produce probabilistic plume dispersion predictions.

PHASE I: Investigate and develop validation algorithms and error characterization schemes which are appropriate for mesoscale NWP models and probabilistic dispersion prediction.

PHASE II: Generalize a set of algorithms to work with current DTRA NWP model and observational data streams in order to allow the definition of model skill and make estimates of model error characteristics on a regular basis.

PHASE III: The outcomes of the investigation will have a wide variety of military and commercial applications in war theatre and civil weather forecasting, and in theatre and homeland security plume hazard analysis applications.

REFERENCES:
White, B. G., J. Paegle, W. J. Steenburgh, J. D. Horel, R. T. Swanson, L. K. Cook, D. J. Onton, and J. G. Miles, 1999: Short-term forecast validation of six models. Wea. Forecasting, 14, 84-107.

Satyamurty, Prakki, Bittencourt, Daniel Pires. 1999: Performance Evaluation Statistics Applied to Derived Fields of NWP Model Forecasts. Weather and
Forecasting: Vol. 14, No. 5, pp. 726-740.

KEYWORDS: Meteorology, numerical weather prediction, NWP, weather, mesoscale, error/validation statistics

DTRA04-004 TITLE: Improve high altitude transport and dispersion (T&D) modeling capability through incorporation of upper atmospheric observations into T&D models.

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: DTRA requires a technical solution that enables collection and use of remotely-sensed upper atmospheric data to improve predictive capabilities of both meteorological and T&D models.

DESCRIPTION: Currently, the lack of measured/observed meteorological data in the upper atmosphere limits our ability to accurately model high altitude transport and dispersion of materials in the stratosphere (such as from a missile intercept). Conventional atmospheric observing techniques either do not reach the upper atmosphere or do not resolve that atmospheric region well. T&D models require good weather inputs in order to produce good predictions. Observed data are required for model evaluation as well. Upper atmospheric sounding data from GPS satellites already exists, but not in a form useable by NWP models. An innovative data retrieval and processing method is required to enable this data to be incorporated (in real time) into NWP and T&D models.

PHASE I: Investigate and develop prototype algorithms for upper atmospheric observation appropriate for mesoscale NWP models and probabilistic dispersion prediction.

PHASE II: Generalize a set of algorithms to work with current DTRA NWP model and observational data streams that will take the limited observations and apply them throughout the area of interest.

PHASE III: The outcomes of the investigation will have a wide variety of military and commercial applications in war theatre and civil weather forecasting, in ozone/global warming understanding, and in theatre and homeland security plume hazard analysis applications.

REFERENCES:
White, B. G., J. Paegle, W. J. Steenburgh, J. D. Horel, R. T. Swanson, L. K. Cook, D. J. Onton, and J. G. Miles, 1999: Short-term forecast validation of six models. Wea. Forecasting, 14, 84-107.

Satyamurty, Prakki, Bittencourt, Daniel Pires. 1999: Performance Evaluation Statistics Applied to Derived Fields of NWP Model Forecasts. Weather and
Forecasting: Vol. 14, No. 5, pp. 726-740.

KEYWORDS: Meteorology, numerical weather prediction, NWP, weather, stratosphere

DTRA04-005 TITLE: <u>Air-water hazard model</u>

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: DTRA requires an innovative solution to represent a true air-to-water interaction including hazardous materials.

DESCRIPTION: DTRA is lacking in a true interactive development understanding of the water/sea to boundary layer influences especially including the chemistry and physics of hazardous material transport, diffusion and scavenging.

PHASE I: Investigate and develop prototype algorithms for water/sea to boundary layer influences and propose a method for incorporating associated chemistry/physics of hazardous materials consistent with existing DTRA numerical weather prediction (NWP) models and probabilistic dispersion prediction.

PHASE II: Develop, validate and generalize a set of algorithms to work with current DTRA NWP model and probabilistic dispersion prediction.

PHASE III: The outcomes of the investigation will have a wide variety of military and commercial applications in war theatre and civil homeland security plume hazard analysis applications.

REFERENCES:
http://www.uscg.mil/hq/g-m/
http://www.epa.gov/oilspill/

KEYWORDS: Littoral model, hazard prediction, water/sea interface

DTRA04-006 TITLE: <u>3-Dimensional Hazard and Consequence Assessment Visualization</u>

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: DTRA desires a near real-time automated three-dimensional visualization of geospatial data, time-varying hazards and consequence assessments.

DESCRIPTION: DTRA modeling tools are capable of calculating the time varying 3 dimensional hazard within a geospatial display. Existing technology allows for two-dimensional views and with effort an animation of the time-dependent hazard. Emerging technology will be capable of rendering a pseudo-three dimensional view on a two-dimensional screen. However, a full three-dimensional projection of the information would provide a better visual understanding of the time-varying hazard and its impacts. A near real-time three-dimensional projection of the time-varying hazard prediction would be of interest to DTRA.

PHASE I: Demonstrate a proof-of-concept for an appropriate near-real time three-dimensional display system. Propose a plan to project the time-varying hazard prediction model within the three-dimensional display.

PHASE II: Develop, validate, and automate a three-dimensional display of geospatial and hazard prediction information.

PHASE III: The outcomes of the investigation will have a wide variety of military and commercial applications in war theatre and civil homeland security plume hazard analysis applications.

KEYWORDS: Hazard prediction, visualization, 3-D view

DTRA04-007 TITLE: <u>Understanding and application of the influence of precipitation, clouds, and fog on hazardous material concentrations in the atmosphere</u>

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace, Weapons

OBJECTIVE: Quantify the effects of precipitation, clouds, and fog on the concentration and subsequent transport of hazardous materials in the atmosphere; develop methods for improving HPAC's treatment of precipitation, clouds, and fog by incorporating radar, satellite, and numerical weather prediction data into transport and dispersion calculations.

DESCRIPTION: Cloud cover and precipitation influence the transport and dispersion of hazardous materials primarily through alteration of the radiation budget and scavenging. Although cloud amount and precipitation intensity generally exhibit large gradients over short distances, the Hazard Prediction and Assessment Capability (HPAC) model currently treats these fields as constant over a project domain. Satellite and radar data provide valuable information about cloud and precipitation characteristics. However, the ability to use this information in HPAC does not exist. A method for retrieving and incorporating this type of data into HPAC's T&D calculations is of interest to DTRA. This shortfall affects hazardous material plume characteristics by over/under estimating the effects of washout and radiative effects.

PHASE I: Investigate and develop methods to quantify the effects of precipitation, clouds, and fog on the concentration and subsequent transport of hazardous materials in the atmosphere. Develop methods for improving HPAC's treatment of precipitation, clouds, and fog by incorporating radar, satellite, and numerical weather prediction data into transport and dispersion calculations.

PHASE II: Generalize a set of algorithms to work with current DTRA NWP model and observational data streams in order to account for the effects of clouds and fog on plume concentration within the HPAC modeling system. Develop algorithms for precipitation influences and propose a method for incorporating precipitation data consistent with existing DTRA numerical weather prediction (NWP) models and probabilistic dispersion prediction.

PHASE III: The outcome of the study will provide a greater understanding of atmospheric moisture effects on plume characteristics and will serve to improve all aspects of plume hazard analysis applications. Thus, the investigation will have a wide variety of military and commercial applications in war theatre and civil weather forecasting, and in theatre and homeland security plume hazard analysis applications.

KEYWORDS: Meteorology, numerical weather prediction, NWP, weather, mesoscale, precipitation scavenging

DTRA04-008 TITLE: Characterization of Occupied/Unoccupied Underground Sanctuaries

TECHNOLOGY AREAS: Information Systems, Sensors, Weapons

OBJECTIVE: Previous work has focused on thermal infra-red (IR) imaging of underground voids, structures or facilities, arising out of temperature differences between different parts of the facilities. The objective is to develop an electromagnetic (EM) sensor capability to remotely and accurately identify and characterize the size, depth, occupied or unoccupied stages of the UGF (i.e. caves, bunkers, etc) through the use of broadband (~ MHz to GHz range) technology. At high frequencies of the broadband technology, when the earth is not a good conductor, the penetration depth (e-fold attenuation of EM fields into the ground) becomes a strong function of both the conductivity and dielectric constant of the ground. For a typical dielectric constant of 10 and at conductivity levels of 10-4 to 10-3 S/m for dry ground, one could achieve a penetration depth in the range of 20 to 100m. For wet ground, with the soil conductivity levels of 10-3 to 10-2 S/m and the same dielectric constant, the penetration depth is typically in the range of 1 to 20m.

DESCRIPTION: The problem of detection, localization and characterization of underground sanctuaries such as mountainous caves, underground cellars, bunkers, etc is an extremely complex problem, and it is getting increasing attention recently in response to the relentless effort by the U.S. government to fight terrorism around the world. Perhaps, the ultimate solution to finding and characterizing the sanctuaries is usage of a combination of thermal infrared imagery and electromagnetic imaging techniques. Both approaches should be evaluated separately before one can assess the technical viability of the fusion of these two techniques for better results and high confidence.

Limited technical reports are available in the open literature concerning the thermal IR imagery (Ref. 1&2). To complement the thermal imagery, this research would analyze the feasibility of broadband electromagnetic imaging techniques for:

(1) Deep penetration into the ground by lower frequency band of the synthetic aperture radar (SAR) like EM beam, (2) Generating a high-resolution,3-dimensional tomographic imaging of the underground strata and, (3) The ability to make an assessment of whether or not a sanctuary is occupied by humans or discrete ordnances. Thus, the high-resolution capability is of paramount importance for discrimination against competing ground clutter. It should be emphasized that a foliated terrain should not “obscure” the developed SAR type sensor’s ground penetration capability.

PHASE I: Demonstrate feasibility of detecting and characterizing underground hidden sanctuaries by employing appropriate remote sensing instrumentation, using actual or simulated conditions over an extended period, and covering a broad range of usage of the suspected underground site. Demonstrate utility of the technology using broadband electromagnetic imaging techniques, under varying conditions of facility's structural characteristics.

PHASE II: Using underground space-cavity with both known and unknown characteristics, demonstrate and refine the technology/system initiated in Phase I, and bring the system to a level of accuracy and efficiency for first-issue commercialization. Perform parametric analysis for assessing the technical feasibility of integrating the system into an airborne platform such as UAV and subsequently carry out a preliminary design of an airborne imaging system. Use computer simulations along with the limited scaled experiments to assess airborne system performance. Use tradeoff analysis in the process of selecting the most suitable airborne platform.

PHASE III: Primary objective of this Phase is to build a demonstration prototype system and to integrate it into an affordable airborne platform. Furthermore, limited number of full-scale field tests to be carried out over an apriori selected set of terrains and underground facilities, including caves to demonstrate the system performance.

Moreover, the tests need to include the various soil moisture conditions from very dry to very wet state. In addition to the military application of locating caves or underground voids, this research will have the civilian application for locating old commercial mines to allow reuse of the abandoned mines, for providing geological maps for further prospecting and location maps for public safety.

REFERENCES:
1) Krusinger, A. E., Eastes, J.W. (1995) Surface Radiometric Temperature Study of Mine Shafts and Surrounds, U.S. Army Yuma Proving Grounds, special report to CIA/ORD, Dept. of Commerce, Bureau of Mines, and USGS, Project Western Rainbow, Oct. 1995.
2) Rinker, J. N., (1974), Airborne Infrared Thermal Detection of Caves and Crevasses, Proceedings of the 1974 Fall Meeting of the American Society of Photogrammetry.

KEYWORDS: Broadband EM imaging technology, Terrorist sanctuary, Caves, Abandoned mines, Detection

DTRA04-009 TITLE: <u>Modeling and Prediction of Ground Shock Induced by Penetrating Weapons in Spatially Random Geologic Media</u>

TECHNOLOGY AREAS: Information Systems, Weapons

OBJECTIVE:
1. A method or methods of characterizing, in the statistical or stochastic sense, in situ spatial geologic material property variability for rock types of interest. Of necessity this should include the full non-linear part of the material model and should also include features such as fractures/joints and anisotropy.
2. A proper statistical scheme for measurements on ground shock field-tests which rigorously quantifies the effects of spatial material property. (Measurements from DTRA explosive tests conducted in granite during the past year suggest that peak particle velocity at about the 1-2 kbar stress level may vary as much as a factor of 3 from one measurement location to another at the same range from a symmetric source.)
3. Development of techniques for incorporation of spatially stochastic, non-linear material models in two- and three-dimensional ground shock codes such as DYNA 2D and DYNA 3D.

DESCRIPTION: Ground shock produced by exploding penetrating weapons is a principle kill mechanism for hardened underground facilities such as tunnels, bunkers, etc. Models and prediction schemes for ground shock are developed from large-scale finite difference codes and field and laboratory testing of geologic materials. Several studies (References 1 and 2 for example) have demonstrated that spatial variability in geologic material properties has a significant influence on ground shock produced by explosions. To date, only a couple crude attempts at characterizing this variability in a proper statistical sense have been made (References 1 and 3); and these characterizations have involved only the linear elastic part of the problem. To our knowledge, only one calculational study has properly attacked the problem in terms of ground shock prediction (References 4 and 5). This study was also quite limited in that it attacked the problem only in a one-dimensional, linear elastic sense. The results from this study, however, suggest that the effects on ground shock produced by spatial variability are significant when compared to a similar calculation for the deterministic geologic models commonly used in first principles ground shock prediction codes (References 4 and 5). In the hydrologic community, which deals with similar degrees of geologic heterogeneity, stochastic modeling of water flow and storage has become routine (See references 6 and 7 for example). In short, although everyone in the material property/ground shock community agrees that random spatial geologic material variability is ubiquitous and probably has a significant effect on weapon induced ground shock, no one does anything about it – perhaps because of the formidable nature of the problem.

PHASE I: The phase I objective is the development of a prototype methodology for complying with the three requirements above. Of necessity, this will probably have to be fairly rudimentary and limited to the utilization of preexisting data (including site characterization information and actual explosive test data) from perhaps a single site or testbed. A few suitable data sets may be available from DTRA. The proposer may also suggest suitable preexisting data sets.

PHASE II: Requirements 1 and 2 will be satisfied by the development of a rigorous methodology for statistical characterization of the spatial material property variability of a given site or testbed. In addition, a procedure for determining the quantity and placement of sufficient measurements on an explosive test to adequately characterize the ground shock field in a statistical sense must be supplied.

To fulfill requirement 3, the proposer must demonstrate and supply at least a two-dimensional ground shock code such as DYNA 2D modified to include stochastic spatial variability in material property parameters. Prior to delivery to DTRA and the community, this code shall be satisfactorily demonstrated by comparison with results from an actual explosive test or tests.

PHASE III: The potential Phase III military application is incorporation of stochastic ground shock prediction techniques into operational weapons effects prediction codes such as IMEA. This effort also has applications for the Strategic HTBTD ACTD. Commercial applications are possible in mining and quarrying operations where blasting is used and in the field of earthquake engineering where it has been recognized that spatial ground motion variability is important but no effective technique for dealing with it has been developed. In addition there are potential applications in the fields of petroleum engineering and geohydrology.

REFERENCES:
1. Reinke, Robert E. and Brian W. Stump, 1991, “Experimental studies of stochastic geologic influences on near-source ground motions” in Explosion Source Phenomenology, Geophysical Monograph 65, American Geophysical Union, Washington DC, pages 63-72.
2. Reinke, Robert E. 2003, “First-cut analysis of close-in ground shock from the DA 50 and 51 explosive tests”, DTRA letter report.
3. Reinke, Robert E. and Brian W. Stump, 1988, “Stochastic geologic effects on near-field ground motions in alluvium”, Bulletin of the Seismological Society of America, vol. 78. Pages 430-449.
4. Martinez, Audrey A., 1995, “Ground motion modeling in random geologic media”, in Computational Stochastic Mechanics, A.A. Balkeema, Rotterdam, pages 231-238.
5. Martinez, Audrey A., 1993, One-Dimensional Modeling of Ground Shock Propagation in Spatially Random Geologic Media, Defense Nuclear Agency, DNA TR-92-130, 102 pages.
6. Dagan, Gedeon, 2002, “An overview of stochastic modeling of groundwater flow and transport: from theory to applications”, EOS, Transactions, American Geophysical Union, vol. 83, 31 Dec. 2002.
7. Paleologos, Evangelos, 2003, “A review of Stochastic Methods for Flow in Porous Media, Coping with Uncertainties by Dongxiao Zhang”, book review in EOS, Transactions of the American Geophysical Union, vol. 84, March 4, 2003.

KEYWORDS: Ground shock, penetrating weapons, stochastic geologic variability, material properties, ground shock code, geologic site characterization, spatial geologic variations, ground shock uncertainty.

DTRA04-010 TITLE: Next Generation X-ray Simulator Technologies

TECHNOLOGY AREAS: Information Systems, Sensors, Nuclear Technology

OBJECTIVE: Develop innovative technologies to develop the next generation of DoD's x-ray simulator technology for commercial, industrial, civilian and Government applications.

DESCRIPTION: This solicitation is for research and development (R&D) of concepts, components, software, diagnostics, etc., employing a tunable (frequency or temperature) full-spectrum radiation source and driving system capable of being scaled for testing articles ranging in size from component-sized (IC or transistor) to system-sized (room size). The source will simulate the x-ray and gamma radiation environments generated by a nuclear event.

DoD's x-ray simulator R&D program has historically focused on incremental improvements in pulsed power technologies to produce very intense, short time period x-rays and gamma radiation for testing DoD operational system components and ensuring that the systems will operate if exposed to an offensive or defensive nuclear weapon burst. A paradigm shift in technology is required for any significant improvement in the quality and realism of radiation effects testing. Technology areas of interest include, but are not limited to, the following:

„h Radiation Sources - blackbody and near-blackbody radiation sources (up to 1012 cal gamma and x-ray), high efficiency Plasma Radiation (PRS) (> 30% radiation > 1 KeV) and Bremsstrahlung sources
„h Energy Storage - high voltage, high energy density capacitors (> 3 J/cm3) and superconducting inductors (up to 1MJ)
„h Switches - high coulomb (>1 coul), high current opening and closing switches (10 to 100 MA), low jitter trigger systems (< 2ns)

DoD's x-ray radiation simulator program has been noted for its efforts to ensure that technical spin-offs address commercial, civilian and government needs. Spin-offs have influenced many industrial/civilian applications, to include modern defibrillators and chemical and biological cleanup systems. New broad spectrum X-ray sources could provide better resolution imaging for construction material inspections such as concrete supports for overpasses and I-beams for buildings. High energy density capacitors can be used for miniaturizing defibrillators, camera flashes, and similar devices powered by capacitors. Large sized superconducting inductors could be used for electrical power storage to eliminate the use of peaking stations by the electrical utilities. They can also be used to prevent parasitic oscillations on the power grid to improve efficiency in transmission through power lines and decrease the need for more power lines. The new technologies and technical advancements related to the DoD's x-ray radiation simulator program that are developed under this solicitation are expected to result in similar important commercial, industrial, civilian and Government spin-offs.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test and evaluate proof-of-principle hardware or software. In the event the contractor proposes to demonstrate the prototype in an above ground test simulator, DTRA will coordinate the demonstration at its facility.

PHASE III DUAL USE APPLICATIONS: The Phase I proposals should describe and quantify the manner in which the technologies to be developed could be useful for commercial, industrial, civilian and Government applications. When the technologies to be developed also have application to the DoD's radiation simulator program, such application will be of secondary importance to the other commercial, industrial, civilian and Government applications.

REFERENCES:
PPPS-2001 Pulsed Power Plasma Science 2001. 28th IEEE International Conference on Plasma Science and 13th IEEE International Pulsed Power Conference. Digest of Papers (IEEE Cat. No.01CH37251)

IEE Colloquium on Practical Applications of High Temperature Superconductors, 4 May 1995

SMES: Superconducting Magnetic Energy Storage, Ballistic Missile Defense Organization, Washington, DC, ADA338581, 1993

KEYWORDS: Advanced Simulator, Above Ground Test (AGT), X-ray, Gamma Ray, Near-Blackbody, Blackbody Radiation, Pulsed Power, Radiation, Electronics, Nuclear Weapon Effects, Electromagnetic, High Coulomb Switches, High Energy Capacitors, Static Electrical Storage Devices, Dose, Dose-Rate, Superconductor, Superconducting, High Voltage, High Current.

DTRA04-011 TITLE: New Thermobarics

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: Innovative new formulations are sought for that can release 80-90% percent of their available energy in a few milliseconds with a charge size of a pound in a casing constituting no more than 50% of the total weight, initiated inside a room of 12x12x8 ft3 with a door and a window. Formulations that generate corrosive reaction products that are capable of neutralizing biological agents are also of interest.

DESCRIPTION: It was demonstrated that thermobarics can perform better than conventional high explosives in generating enhanced blasts in certain target configurations. Also it has been shown that performance (generation of blast pressure and impulse) depends on such parameters as ignition temperature of extra fuel being mixed with air, burning duration of such fuel, charge size, degree of confinement (casing), target geometry, charge configuration (such as ones capable of jetting), etc. It is estimated that only 50-60% of the available energy is released in the current set of thermobarics. Potential offerors are encouraged to contact the sponsoring agency for additional background and technical discussions.

PHASE I: Develop one or more formulations wth potential for enhancing blast effect by as much as 50% compared to the best current thermobarics and/or capable of neutalizing biological agents and demonstrate feasibility in labscale tests.

PHASE II: Demonstrate performance of formulation(s) in full scale tests. Enhance formulation(s) to facilitate processing, packaging, dispersion and/or reduce cost.

PHASE III: Produce production quantities for military and law enforcement applications. For conditions in which physical destructon could be tolerated, thermbaric neutralization of a biologica agent could also be applied to accomplish decontamination.

KEYWORDS: thermobarics, formulation, enhanced blast, agent neutralization

DTRA04-012 TITLE: Agent Defeat Weapon Technology

TECHNOLOGY AREAS: Weapons

OBJECTIVE: To provide innovative solutions to improve performance of agent defeat weapons and/or to improve our methods of quantifying such performance

DESCRIPTION: It was demonstrated that agent defeat weapons outperform (defeat enemy targets with less collateral effects) conventional legacy weapons against particular sets of targets. Many technical challenges still remain. For example,

(1) Robust agent defeat weapon concept: How can we make the weapons more robust against various types of targets with various agents of various quantities, especially when we may not have precise intelligence on the targets, our CEP is not adequate or enemy employs countermeasures?

(2) Characterization of biological agent properties: What are good simulants of chemical or biological agents? How can we accurately prepare/characterize bio agents, in terms of spores and CFUs? Are there weak vs hardy populations in a given bio agent batch? If so, how do we treat them? How does one measure infectivity of bio spores, individual spores vs clumps of spores, for example? Are there ways to tell live vs dead spores quickly? Are there good taggants to the spores for easy identification?

(3) Weapon performance improvement: How can we improve the performance (reduce collateral effects while destroying targets or denying access to targets) of weapons? Better payloads? Better weapon designs?

(4) Measurement technology: How can we measure the performance of such weapons more precisely during sub-scale or full-scale tests? How can we best collect/detect/characterize/quantify samples coming out of representative target structures without materially affecting them? Can we improve agent cloud tracking methodology and thereby improve our methods of estimating amounts of live agents (simulants) released during full scale open air tests?

(5) BDA: How can we achieve effective BDA?

Innovative solutions to any one or more of these questions and other related technology issues are sought for. Potential offerors are encouraged to contact DTRA or additional background and technical discussions.

PHASE I: Develop a technology/methodology to answer any of the above issues in a specific weapon-target interaction scenario.

PHASE II: Produce prototype technology/methodology to address any of the above issues in a general weapon-target scenarios.

PHASE III: Apply technology/methodology to weaponization in multiple delivery platforms. Capabilities are also of interest in public health and hazard response/decontamination contexts.

KEYWORDS: Biological agent, agent defeat, BDA, weapons, weapon concept robustness, measurement